Estimating the Indirect Contribution of Sports Books: Sports Wagering as a Driver of Other In-House Revenues

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ABSTRACT

Using data from a repeater market hotel in Las Vegas, Nevada, the relationship between sports book and slot machine revenues is examined. Daily sports book write and daily slot handle are compared over a 250 day period. Though many industry leaders theorize that sports book gamblers also wager in slot banks, the results of this research fail to demonstrate a statistically significant relationship between sports book write and slot coin-in. This study advances literature currently available by establishing the lack of such a relationship and disputing the generally accepted assumption that sports books produce a substantial indirect contribution to slot revenues. While the sports book does generate a fairly constant direct profit for the casino, the absolute value of that profit is minimal and the results of the study show there is no indirect profit contribution from sports books to slot machines. Given these results, casino management may want to consider that a sports book is not an optimal use of casino floor space.
Keywords: *Sports books, time series, ARIMA, operations analysis, casino management*

INTRODUCTION

The purpose of this study is to explore the impact of sports book gaming volume on slot gaming volume at a Las Vegas repeater market, familiarly called "locals," casino property by estimating the indirect cash flow contribution of the sports book on slot coin-in - the amount of money wagered on the slot floor. While the sports book's income statements provide a detailed look at the revenues and costs of management, the operation can require many operational costs. There are also potential opportunity costs; the casino could be using the space for more profitable amenities. It is possible, however, that the indirect benefits of having a sports book may justify the operational costs of such a facility.

Practical Significance

Many industry leaders purport that sports gamblers take their winnings from the book and use them to play other in-house games and spend them on other property amenities (Lang & Roxborough, 1992; Manteris, 1993; Roxborough, 1996). While these operators have discussed the indirect benefit of sports books on the casino floor for many years, as yet none have provided any empirical proof of their claims. In addition, the current troubled economic times are leading some state governments to seek legalized sports betting (McCarthy & Perez, 2009). In Delaware, for example, this legislation has come to fruition, and casino operators should heed advice and find empirical evidence of the value of a sports book before investing their time and money.

Academic Significance

This study presents a functional model and objective process for estimating the indirect gaming contribution of sports book volume to associated gaming volumes, most specifically slot coin-in. Lucas, Dunn, & Kharitonova (2006) first addressed the issue of indirect gaming contributions with respect to bingo, and also created the theoretical framework which opened the door to further analysis of other indirect gaming contributions. This study will expand on current gaming literature by concentrating on the sports book, a casino staple for many years.

LITERATURE REVIEW

The In-House Sports Book –A Desired Amenity?

Kilby, Fox, & Lucas (2005) state that ultimately, all games in the casino compete for floor space via profit per square foot. This does not necessarily relate to direct profit, as many casino operations departments will keep some poorly-grossing operations that consistently take a loss with the belief that they will drive other revenues on the property. When considering the highest and best use of space, Kilby et al. (2005) inspire the question – does a sports book constitute the most valuable use of the property's facilities?

Noting how the sports book provides access to other attractions within the casino-hotel, Lang and Roxborough (1992) postulate that the sports book serves the latent function of keeping pit players near the action. While Roxborough (1996) declares the sports book to be a core profit center, Manteris (1993) proposes that while the sports book itself may not generate high revenues, the opening and expansion of sports books within casino-hotels runs hand-in-hand with increases in hotel, food and beverage, and slot and casino revenues. Eng (2008) details Mantras's explanation that a state-of-the-art race and sports book is a big draw to the property, since it "gives the guests what they want," and that customers who come to the property to wager at the book will use the other facility services – most specifically, the "king of gambling profits": the slot machine.

The Age of the Internet

Race and sports gambling have come a long way since the days of hand-written tickets and chalk blackboards listing various odds (Nover, 2008). Sports betting online is currently illegal, since the United States Court of Appeals ruled that the Federal Wire Act prohibited sports wagering over the Internet (Thompson v. Mastercard, 2002). It is also important to consider that should online wagering once again become legal, many new internet wagering sites are expected to crop up and land-based sports books may be facing further struggles to get patrons to leave the comfort of their own home to come to the casino.

Slot Machines as Revenue Drivers and Indirect Effects

Slot coin-in is preferred as the dependent variable in this study because slot performance has been reviewed to be central to the continued success of most casino operations (Lucas et al., 2006). The term "slot machine" is used by the casino industry to describe any video poker, reel slot, multi-game, or video keno machine (Lucas & Brewer, 2001). Brewer and Cummings (1995) found that slot revenues typically account for 50-80% of total casino revenue, a significant increase over their revenue contribution from years prior to 1995. The Nevada Gaming Control Board (2009) shows slot revenues reliably composing the vast majority of total gaming revenues of hotel casino properties outside the Las Vegas Strip and downtown markets, and still a very large portion of revenues in those two markets.

Lucas and Brewer (2001) examined a theoretical model designed to explain the variation in daily slot handle at a locals market casino in Las Vegas. Using a regression model to look at variables that had been hypothesized to influence slot handle by previous research, Lucas and Brewer found that several variables, including bingo headcount, produced a significant effect on daily slot handle.

Lucas et al. (2006) examined data provided by repeater market casinos, and determined that bingo was not a positive significant contributor to slot coin-in, and yet it was used as a loss-leader – that is, the bingo room had negative revenues and was using valuable floor space that could otherwise be used by more profitable gaming amenities. Ollstein (2006) used a similar methodology to examine the indirect gaming contribution of poker to slot coin-in, and found that poker rake served as a valid driver of slot revenue but the marginal financial benefit was low.

Theoretical Model

The theoretical model depicted in Figure 1 is derived from the literature review of models proposed in an attempt to describe the variations in daily gaming volumes (Lucas, 2004; Lucas & Bowen, 2002; Lucas & Brewer, 2001; Lucas et al., 2006; Lucas & Santos, 2003). Variables which are known to contribute to multicollinearity in accordance with day of the week, such as hotel occupancy and restaurant headcount, are not included in the model as they are related to associated business volumes and may exhibit collinear behaviors (Lucas & Kilby, 2002).

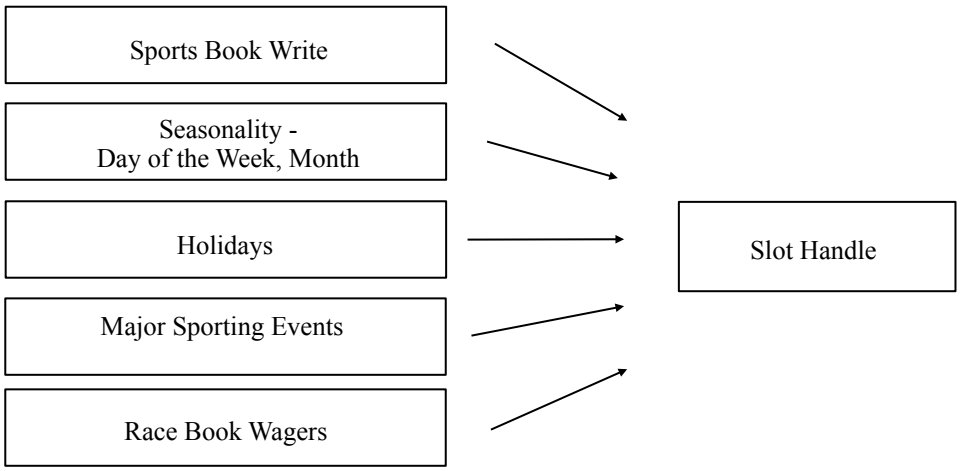

Figure 1. General theoretical model for analysis.

Hypothesis

Based on analysis of the literature, the null hypothesis is described as the following:

$$H_0 : \beta_{SportsBookDailyWagers} = 0$$

Null Hypothesis: There is no relationship between the dollar value of aggregate daily wagers for the sports book and aggregate daily slot handle.

METHODOLOGY

One Las Vegas repeater market hotel casino provided the secondary data applied to the theoretical model. The hotel casino operates a sports book but relies on slot machines as the primary source of their revenues. The data set includes daily results across a 250-day period, beginning on January 1, 2009, and ending on September 7, 2009. The casino property described its sports book as a profitable operation, with a profit margin near 35%. The actual dollar amount of sports book profit, however, only totals approximately 2% of slot profit.

Data Analysis

The data were screened in R, an open source statistical software package, to ensure accuracy of data entry, missing values, normality of the distribution, and goodness-of-fit between distributions. Line graphs of aggregate daily sports book wagers were evaluated for occurrences of seasonality. The formal data analysis was also conducted using R, which allows for the user to address the serial correlation of error terms that is often present in time series data analysis. The hypothesis was tested via an ARIMA analysis, and further diagnostic tests were administered to ensure the model was appropriate for the data set.

Expression of the Criterion Variable

Daily Slot Handle represents the dependent variable in the model data set, and is defined as the dollar amount of wagers made on all coin- or voucher-operated gaming devices currently active on the casino floor. The casino property analyzed offered a number of different slot machine systems at the time of data capture, including video keno, video poker, video blackjack, reel slots, and progressive systems.

Expression of Predictor Variables

Aggregate daily wagers placed at the sports book is represented by the Daily Sports Book Write variable. It is proper to use the incoming wagers as a measure of sports book betting activity rather than the aggregate of paid out win tickets for all cases, because win tickets paid out to patrons are dependent on game outcome and on the casino's payoff odds, which vary as the line moves.

Seasonality and holiday periods are described by day and month binary variables. Seasonality is innately present in sports book wagering, because unlike most casino game wagers, which do not change as time passes, sports wagering options are different not only by month, but by day. Holidays are theoretically tied to an increase in patron leisure time and as such to an increase in gaming volume. In past studies, holiday variables such as these have been found to produce significant effects on gaming volume (Lucas et. al., 2006).

Binary variables are additionally used to represent major sporting events to explain variations in gaming volume that occur when major sporting events draw in a crowd that may temporarily inflate that day's or set of day's sports write, such as the Superbowl. Because a sporting event could conceivably elevate gaming volume levels beyond the scope of a single day, some major sporting events were depicted within the indicator variable over a period of days, rather than just the day on which the event took place. A compilation of the sporting event indicator variables included in this model can be found in Table 1.

Table 1
Major Sporting Events Included in the Model as Indicator Variables

Event	Date(s)
Super Bowl – National Football League	February 1, 2009
National Basketball Association All Star Game	February 15, 2009
March Madness – NCAA Championships, Basketball	March 26 – March 29, April 4, April 6, 2009
The Masters Golf Tournament	April 6 – April 12, 2009
Kentucky Derby – Horse Racing	May 2, 2009
Preakness Stakes – Horse Racing	May 16, 2009
Indianapolis 500 – Motor Sport	May 24, 2009
National Basketball Association Championships	June 4, June 7, June 9, June 11, June 14, 2009
Belmont Stakes – Horse Racing	June 6, 2009
US Open – Professional Golfers Association Tour	June 15 – June 21, 2009

Aggregate race book win represents the revenue earned by the casino on race book wagers. On a race book bet, all wagered money goes into a pool, and the proportion of money in the pool that is wagered on each entrant in the race determine its odds. The casino's book then takes a percentage out of the pool of pari-mutuel wagers.

RESULTS

Preliminary diagnostic tests were run on the data set before performing initial analyses to screen for outliers and nonlinear conditions. One extreme outlier was identified, the day of the Super Bowl. A histogram of the dependent variable, slot coin-in, was reviewed with regard to the normality of distribution, and was found to be slightly skewed in a positive direction. Reviews of a live graph plotting slot coin-in against time indicated a small but constant downward trend. Table 2 below comprises a summary of the descriptive statistics for daily slot handle, the dependent variable, and daily sports book write, the independent variable.

Table 2
Descriptive Statistics for Major Dependent and Independent Variables

Variable	Minimum	Maximum	Mean	Median	Standard Deviation
Daily Slot Handle	2,944,266	9,093,829	4,989,531	4,629,077	1,324,044
Daily Sports Book Write	1,221	707,252	60,867	50,474	54,284

The initial regression model produced a multiple R^2 value of 0.896 and an adjusted R^2 value of 0.889, both substantially high, and a significant F statistic (F=117.8, df=17,232, p-value < 0.00001). A screening of the autocorrelation function (ACF) and the partial autocorrelation function (PACF), however, revealed serial correlation in the model. Because the value of Daily Slot Handle observed at any given time t_i may depend on values observed at other points in time, time series data tends to violate independence assumptions of a linear regression model. As a result, an Autoregressive Integrated Moving Average (ARIMA) analysis was run on the model.

ARIMA Time Series Analysis

The ARIMA model is used to uncover lags and shifts in the data that occur over time, and uses patterns like moving averages and seasonality to generate a prediction model. The ARIMA model accounts for temporal dependence found in seasonal and systematic trends in several ways, as described by Grimmer's research in R (as cited in Imai, King, & Lau, 2007). Within the R statistical program, a time series data set is differenced to render it stationary, then the time dependence of the stationary process is modeled, including autoregressive and moving average terms, as well as any other time-dependent covariates. When utilizing an ARIMA model, a trend

variable is not used because the "integrated" ARIMA already accounts for trend found in time series during its formulations. The ARIMA model notation takes the form of ARIMA (*p*,*d*,*q*), in which *p* represents the order of the autoregressive (AR) part, *d* represents the order of the integrated differencing (I), and *q* represents the order of the moving average (MA) process. When the trend variable is incorporated in the model, *d* will equal zero.

An examination of the regression model's ACF and PACF plots indicated the presence of a moving average component of 2, due to significant spikes at early lag periods. An ARIMA(0,1,2) model was fitted on the data set, and included all independent variables that had been found significant in multiple regression. ARIMA (0,0,1) and ARIMA (0,0,2) models were also fitted, but an analysis of the Akaike Information Criterion (AIC) indicated the ARIMA (0,1,2) model was best. The first ARIMA (0,1,2) model run found that Daily Sports Write was not significant in the model (p=0.293), so a second model was run (Table 3), and this final model was analyzed to ensure goodness of fit without the primary investigative independent variable. All coefficients in the final model are significant at the 0.05 alpha level, with the exception of August, which is still well within a 0.10 cut off and was therefore kept in this exploratory model. MA(1) and MA(2) represent the first- and second-period moving average terms that were included in the model to remove serial correlation in the error process. Without these two terms, coefficients would include bias due to dependent error terms.

Table 3
Summary of ARIMA Time Series for Variables Predicting Daily Slot Handle with Daily Sports Write Dropped

Variable	β Estimate	β Standard Error	P-value
MA(1)	-0.6831	0.0573	$< 2\times10^{-16}$ ***
MA(2)	-0.2434	0.0563	1.53×10^{-5} ***
February	283,037.6	143,662.7	0.0488*
August	-307,558.1	162,524.2	0.0584
Wednesday	649,057.9	83,944.9	1.05×10^{-14} ***
Thursday	509,161.1	91,937.9	3.05×10^{-8} ***
Friday	2,941,311.0	91,987.0	$< 2\times10^{-16}$ ***
Saturday	2,592,085.0	91,937.5	$< 2\times10^{-16}$ ***
Sunday	812,464.8	84,136.8	$< 2\times10^{-16}$ ***
New Years Weekend	1,265,580.0	279,747.2	6.07×10^{-6} ***
Martin Luther King, Jr. Weekend	760,431.9	292,317.0	0.0093**
President's Day Weekend	1,576,059.0	294,272.5	8.52×10^{-8} ***
Memorial Day Weekend	1,026,654.0	273,979.6	0.0002***
Labor Day Weekend	905,906.7	328,930.3	0.0059**
Indianapolis 500	1,047,416.0	431,715.6	0.0153*

Note. *** < 0.001, ** < 0.01, * < 0.05. Maximum Likelihood Error (MLE) of the innovations variance is estimated at 1.82×10^{11}. Maximized log-likelihood = -3,582.53. AIC = 7,197.06.

Diagnostic Tests of ARIMA Analysis

Examinations of the normal Q-Q plot and histograms failed to indicate a departure from normality nor any problematic outliers, respectively. ACF (see Figure 2) and PACF (see Figure 3) residual plots for the final ARIMA model and show elimination of peaks seen during the regression analysis, although the ACF plot shows significant peaks still remain in the model at lags 7, 10, and 14. A review of the PACF also indicates significant peaks at lags 7, 10, and 14. Because these peaks are not extremely far outside the cutoff, they do not take away significant value from the model, but it is important to note that there could be issues with correlation between days of the week in the data set.

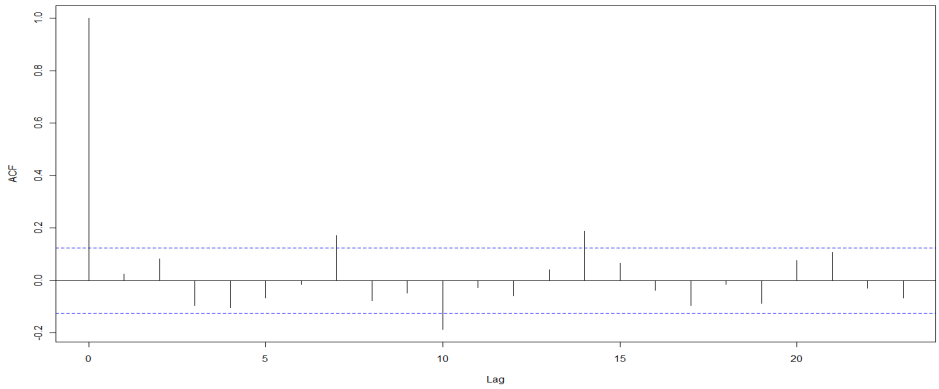

Figure 2. Autocorrelation function residual plot of ARIMA (0,1,2) model.

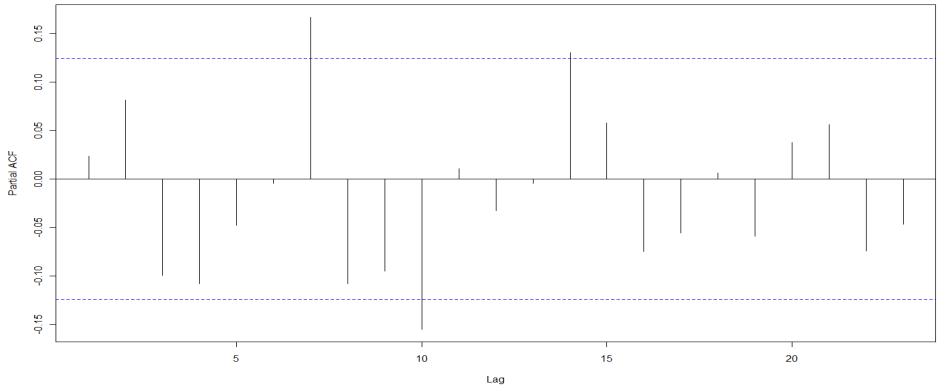

Figure 3. Partial autocorrelation function residual plot of ARIMA (0,1,2) model.

Ljung-Box statistics were examined for the first ten lag values, seen in Table 4, and demonstrate that residuals are independently distributed for the first six lag periods at p=0.05 and the first nine lag periods at p=0.01. When reviewing Table 4 in conjunction with Figures 2 and 3, the lag spikes seen on the ACF and PACF for the seven-period lag become less alarming. While those spikes initially were cause from concern, the Ljung-Box statistic at the seven-period lag is not significant at the 0.01 alpha level, and is near to the 0.05 cutoff.

Table 4
Ljung-Box Statistics ARIMA (0,1,2) Model

Lag Period	Ljung Box Test Statistic Value	Degrees of Freedom	P-Value
1	0.1389	1	0.7093
2	1.8198	2	0.4026
3	4.0799	3	0.2530
4	6.7891	4	0.1475
5	7.9323	5	0.1600
6	7.9912	6	0.2387
7	15.3091	7	0.0322
8	16.7894	8	0.0324
9	17.3768	9	0.0431
10	26.0667	10	0.0037

DISCUSSION

With regard to the primary independent variable, Daily Sports Write, the ARIMA analysis failed to reject the null hypothesis. There was no support of the alternative hypothesis that daily sports write had a significant impact on daily slot coin-in. In addition, it is important to note that race book win not only did not have a significant impact on daily slot coin-in, it was deemed a non-contributor to the model early in analysis and was removed from consideration. This finding comes in contradiction of the theories held by several casino operations managers (Eng, 2008; Lang & Roxborough, 1992; Manteris, 1993).

Managerial Implications

The research conducted herein does not support the theory proposed by industry professionals that the floor is a full-service model, when considering the incorporation of either a sports or race book. The results of this research did not produce any evidence of a positive, significant, indirect contribution from sports nor race books to slot coin-in. At a very minimum, casino operators should give a second thought to sports and race book operations. The sports book does turn a profit but the actual dollar amount of this profit is minimal, particularly when compared to slot handle, as can be seen in Table 2.

As Lucas, Dunn, and Kharitonova (2006) describe, casino management ought to consider both the direct and indirect revenue contributions of gaming and facility amenities, and must ultimately decide what combination of each operational element maximizes the property's profit per square foot. The results demonstrated here fail to provide any empirical evidence that the sports book serves as a driver of slot revenues on the property. Ultimately, the decision must be made based on empirical proof and dedication to optimizing profit per square foot, rather than blindly following the declarations of unsupported theory. Lucas et al. (2006) further suggest that not all patrons offer the same profit potential - the sports book may serve the needs of many patrons, but their individual value to the casino may vary greatly. A sports book that covers prime casino floor space may not be the ideal choice for optimizing cash flows.

Because a slot machine requires very low operational cost, and because of the low variance generated by the large aggregate number of spins per hour, even an infrequently played machine may generate higher cash flows for the property than the sports book might. It is typical of a Las Vegas casino to experience attendance and volume peaks during holidays and weekends and troughs during midweek periods. Due to the timing of sporting events, sports books can generate patronage during slower periods. The property may be able to increase their profit per square foot by using some sports book floor space for extra slot capacity during peak slot volume periods that coincide with lulls in sports book volume periods. Unfortunately, it is difficult to quickly convert the space from sports book floor to slot floor and back again on a frequent basis. With the advent of innovative concepts like server-based gaming, management should consider incorporating slot terminals into their sports book operation. A bettor could make sports wagers from their slot terminal while playing the reels, without ever needing to leave their seat.

Following the same line of questioning that Lucas et al. (2006) put forth in their bingo analysis, managers must ask themselves a series of questions when determining the value and size of a sports book on their property. What would the impact be on slot revenue if a casino severely downsized or even removed the sports book from their property? Would patrons whose primary reason for coming to the property still patronize the establishment? Would the casino lose slot revenues due to the loss of the niche clientele? If so, how much revenue would be lost? What gains may occur if the space is used for an expansion of the slot floor? All these questions are certainly dependent on local competition. In a highly saturated market like Las Vegas, both on the Strip and in locals casinos, in which nearly all casinos have a sports book amenity, one might expect a decrease in patronage following the closing of an on-property sports book.

Limitations

The first and most evident limitation of the study is that the data come from a single Las Vegas repeater market property. Because of this, the results will not necessarily be generalizible to casinos in other cities, Las Vegas Strip casinos, nor to other Las Vegas repeater market casinos. The information derived from the study, however, will help the host property in casino marketing decision-making processes and provide a model and process for others to follow.

In addition, the data set used does not include any information on promotional events that occurred at the host property. There are major sporting event dates missing from the data set (i.e. Major League Baseball), because these events did not occur within the data time period.

The nature of timing of wagers at at sports book wagers provides an additional limitation. Bets are made not just moments before the game is played, but can be completed earlier in the day, week, or at any length of time before the event actually occurs, based on the house's willingness to accept the wager. The wager is counted as sports book write on the day it was placed, and was not incorporated in the indicator variables used for the major sporting events. In addition, the effects of the ever-growing population of online sports bettors is not acknowledged.

The research conducted here only delves into the seasonality variation that transpires by day and by month. Within the sports book, however, there are natural fluctuations that occur within a single day period due to the timing of sporting events. It is possible that because the data was gathered at a daily grain rather than an hourly grain, there may be an over-aggregation of actual results. It is also possible that the indirect contribution from the sports book to slot volume may be deflated due to large durations of time in which the sports book is extremely slow because there is no live feed of games.

Recommendations for Future Research

Replication of this study at a different property would provide a stronger foundation for the claims made in this research and would become a balancing asset for industry decision-makers. In addition, an in-depth look at the net financial success of individual sports book promotions might help the casino create an interesting cost-benefit analysis. Expanding the scope of their exploration by collecting data at an hourly grain, rather than the daily grain at which this data was collected, would also be beneficial. Over-aggregation of periodic results may be avoided with more sectionalized compilation of data.

It would also be beneficial to set up observation studies, in which researchers would discreetly follow patrons as they wagered in the sports book and record their actions after they left the amenity, in order to see how they spent the remainder of their time on the property. Qualitative studies like in-depth ZMET interviews or focus groups may also be beneficial, and would contribute greatly to the validity of the research claims.

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